

THE EARTHWORMS OF LAHORE.

BY

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The present paper is the outcome of investigations made at the suggestion of my worthy Professor, Lt.-Col. J. Stephenson, D.Sc., I.M.S., Professor of Zoology and the Principal of the Government College, Lahore. The work was continued over a year because of the observations on the seasonal prevalence of the various forms, as also the very large collections made. For comparison the collections sent to Lt.-Col. Stephenson by the Indian Museum for identification were also examined, as also the private collections of the same distinguished authority. Moreover on the occasion of a visit to the Indian Museum, Calcutta, I was able, through the kindness of Dr. Annandale, Superintendent of the Indian Museum, to examine and compare my specimens with those named by Dr. Michaelsen (2).

I have to offer my sincere thanks to Lt.-Col. Stephenson for the kind help and advice given all the time while I was engaged on this work and for the facilities given.

In all, representatives of the genera *Helodrilus* (Hoffmstr. and Mchlsn.), *Pheretima* (Kinb. and Mchlsn.), *Lampito* (Kinb.) were found in Lahore, while two subgenera of the genus *Helodrilus*, viz., *Allolobophora* (Eisen and Rosa) and *Bimastus* (H. F. Moore) were to be found. The various species found are the following:

1. *Helodrilus (allolobophora) caliginosus* forma *trapezoides* (Dug.).
2. *Helodrilus (Bimastus) parvus* (Eisen).
3. *Pheretima hawayana* (Rosa).
 - (a) Subspecies *typica* (Rosa).
 - (b) Subspecies *barbadensis* (Beddard).
4. *Pheretima posthuma* (L. Vaill.).
5. *Pheretima heterochæta* (Mchlsn.).
6. *Lampito mauritii* (Kinb.).

The nomenclature followed is that given by Michaelsen (1 and 2) except in the case of the two subspecies *typica* and *barbadensis* of *Pheretima hawayana*, this is fully treated in remarks at the end of the species.

KEY FOR THE IDENTIFICATION OF THE VARIOUS GENERA.

Clitellum saddle shaped over many segments. *Helodrilus*.

Clitellum as a ring over three segments, xiv-xvi. *Pheretima*.

Clitellum as a ring over four segments, xiv-xvii. *Lampito*.

The two subgenera *Allolobophora* and *Bimastus* can be distinguished by the very small size and reddish colour of *Bimastus* as compared with very large size and brown colour of *Allolobophora*.

SEASONAL VARIATION IN THE NUMBERS OF VARIOUS SPECIES OF EARTHWORMS.

In December 1913, when the work of collection was begun, but for a few specimens of *Pheretima posthuma* found very deep down in moist and shady places, and large numbers of specimens of *Pheretima hawayana* forma *typica* usually found under flower pots or large wooden logs or stones, the predominant forms were *Helodrilus caliginosus* forma *trapezoides* and the small

Helodrilus parvus. This remained the condition during *January* and *February* 1914. Towards the end of *February* 1914 a few specimens of *barbadensis* form of *Pheretima hawayana*, and *Pheretima heterochaeta* were also picked up. *Helodrilus caliginosus* was met with now in very much smaller numbers so much so that in *May* not a single specimen was found. The various species of the genus *Pheretima* have increased in numbers in the following order:—

Pheretima hawayana, both typical and *barbadensis* forms, *Pheretima heterochaeta*, *Pheretima posthuma*. *Pheretima hawayana* forma *typica* was found throughout in very large numbers, and *Pheretima posthuma* appears to be in very very much smaller numbers than all others. *Helodrilus parvus* is always found with other forms as a small roundish worm. Not a single specimen of *Lampito mauritii* was found, the time during which it is found appears to be the months of August to November, for it was found by Lt.-Col. J. Stephenson, D.Sc., I.M.S., at that time.*

HELODRILUS (ALLOLOBOPHORA) CALIGINOSUS, Sav.

Forma *trapezoides* (Ant. Dug.).

Habitat.—Very widely distributed throughout the city of Lahore, was found in very various localities, in gardens, in cultivated lands, in damp soil near wells, under flower pots, large stones or wooden logs, but in all cases where it was found, the soil was very much more damp than in the situations where the other worms were found; hence from the seasonal variations in the numbers of this worm and the localities in which it was found it follows that the worm loves cold and moisture more than others.

External Characters.—

Length—105—140 mms., diameter $4.5\frac{1}{2}$ mm. at the posterior end to 6 mm. in the anterior part of the body.

Segments 133-190, usually about 145.

Colour.—Very different in specimens from different localities. It varies from pale white to dark brown, usually dark brown to brown with a purplish tinge, light brown ventrally; clitellum distinctly paler and well marked.

Prostomium epilobous ($\frac{2}{3}$ — $\frac{3}{4}$) with a furrow cutting off the backwardly projecting tongue from the rest; the prostomium is partly under cover of the first segment. Segments i—vi consist of single annuli, the rest of two annuli in some of the larger segments each annulus is again cut up in two by a furrow.

Setæ closely paired, 8 in each segment.

Median lateral distance is nearly equal to the median lateral while much smaller than the median dorsal.

$$(aa=4.5 \ ab=4.5 \ cd=bc) \ dd=\frac{1}{2} \ n \text{ nearly.}$$

The first segment is without setæ, but all the others have rather large ones, the setæ are quite distinctly seen even on the clitellum, size of the setæ varies, and by the size and appearance two types of setæ can be distinguished.

1. Setæ on the clitellum and segments ix, x, xi, xv, xvi especially setæ *a* and *b* are rather slender and very much pointed. The setæ are very much curved posteriorly, while nearly straight at the free anterior end, in some cases a little bifurcation of the free anterior end is also seen (Fig. 11, Plate I).

Size.—Length .8—·9 mm.

Thickness .0208—·0260 mm.

Thickness at the *nodulus* .0364 mm.

* Since the above was written, I have secured specimens of this form in Lahore during the months of October and November 1915.

2. Other setæ are nearly of the same size, they are stouter and are *f* shaped being slightly curved anteriorly as well as posteriorly in opposite directions (Fig. 12, Plate I).

Size.—Length .5 mm.

Thickness .0416 mm.

Thickness at the *nodulus* .0572 mm.

The dorsal pores are large and conspicuous, the first is in intersegmental furrow $\frac{9}{10}$. In some specimens distinguishable on the clitellum also.

Clitellum (Fig. 5, Plate I) saddle-shaped, very much raised than the rest of the body, ventrally the segments are not modified and the intersegmental furrows are quite distinct.

Usually the clitellum occupies segments xxvii,—xxxiii or xxxiv (7 or 8) as is stated by Michaelsen (1) and by Pignet (3), but it was observed that in some specimens it occupied xxvi,—xxxiv (=9 segments), while in others xxvii— $\frac{1}{2}$ xxxv (=8 $\frac{1}{2}$ segments) in others xxvi— $\frac{1}{2}$ xxxv (=9 $\frac{1}{2}$ segments) and in still others xxvi-xxxv (=10 segments).

Male pores on segment xv appears as transverse slits between two thick glandular looking lips which overhang anteriorly as well as posteriorly, the lips extend on each side and meet with those of the opposite side and extend on to segments xiv and xvi also (Fig. 9, Plate I).

Female pores indistinct when seen, they are small openings on segment xiv slightly internal to the line of the male pores.

Spermathecal pores not seen.

Genital markings.—Glandular cushion-like borders in the form of ridges continuous with the ventro-lateral borders of the clitellum are present from segments xxxi-xxxiii usually, but in other cases the cushions extend variously on the right and left sides of the same worm (Right $\frac{1}{2}$ xxxi— $\frac{1}{2}$ xxxiv, Left xxx—xxxii or *vice versa* and so on). There are glandular oval patches on the clitellum ventrally on segments xxvii, xxix, xxx, xxxi, xxxii or on xxvii, xxix, xxxi and still differently in others; the glandular patches are in some cases found on both sides, in others alternately on the right and left sides, and in others on some segments on both sides, and on the rest on one side only. When on both sides the glandular areas may meet in the middle line forming a continuous ridge. The glandular areas surround the setæ *a* and *b* (Fig. 10, Plate I).

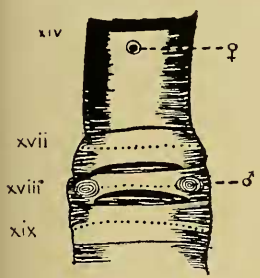
Setæ a and *b* on segments ix, x, xi are in all cases surrounded by glandular areas which meet each other and in the middle line to form a raised patch over all the three segments (Fig. 9, Plate I). The thick glandular lips overhanging the male pores and encroaching on the segments xiv and xvi may also be noted here.

Internal anatomy.—First definite septum is $\frac{4}{5}$ septa $\frac{5}{8}$ — $\frac{7}{10}$ all thickened while $\frac{7}{8}$ is very much thickened than others, $\frac{1}{11}$, $\frac{1}{13}$ also thickened.

Alimentary tract.—The mouth leads into the *buccal cavity* which is small and occupies the first three segments. The *pharynx* which follows has thick muscular walls connected with the body-wall by strands of muscle fibres which run obliquely backwards, it extends up to the vii segment.

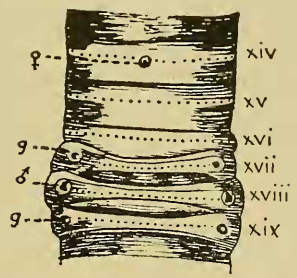
The *Oesophagus* is a straight tube extending from the pharynx to the xiii segment, it appears dilated in each segment while constricted intersegmentally. In the segment xi are given off short lateral diverticulæ or pouches from the oesophagus, these lie in segment x. The *calcareous glands* are two lateral protuberances on the sides of the oesophagus in xi and xii; these are hollow and in longitudinal sections show lamellated appearance; these communicate with one another and with the oesophageal pouches lying in front of them. The *crop* is a large dilated portion of the alimentary canal in segments xiii—xvi. It is a thin walled sac and is separated from the thick walled, *gizzard*, which follows, by a distinct groove. The *Gizzard*

Fig 1.



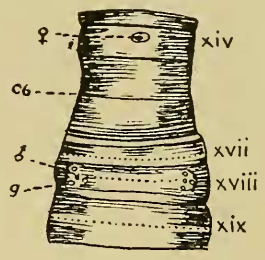
x 5

Fig 2.



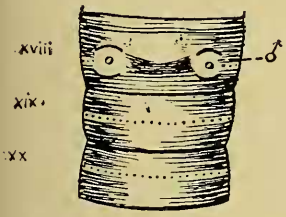
x 7

Fig 3.



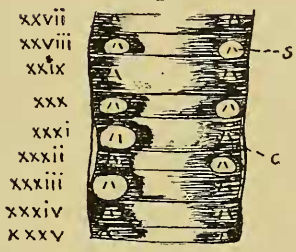
x 5

Fig 6



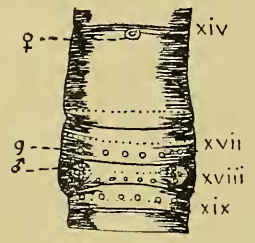
x 7

Fig 5.



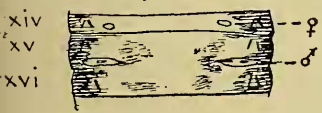
x 5

Fig 4



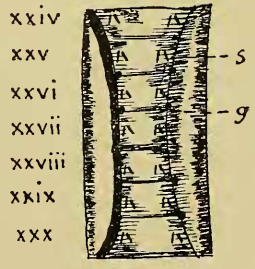
x 5

Fig 9



x 7

Fig 8



x 10

Fig 10



x 7

Fig 11.



Fig 12.



Fig 13.



Fig 14.

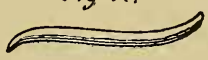
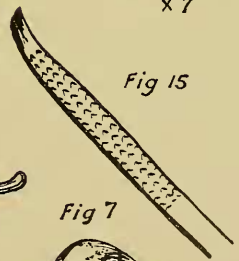


Fig 7



x 4

occupies xvii—xxix sometimes segment xx is also encroached on. Behind the xxix or in other cases xx segment the intestine stretches without change to the anus. It is a thin walled tube slightly constricted intersegmentally owing to the septa. The *typhlosole* is a deep longitudinal groove along the dorsal surface of the intestine projecting into its cavity, owing to the typhlosole the appearance of the intestine is quite horse-shoe shaped in transverse sections.

There are 6 pairs of *hearts* in segments vii—xii.

Excretory system.—*Nephridia* are of the meganephric type. They are arranged in pairs alongside the intestine in each segment, but for the first four and a last few in which they are absent.

The *reproductive* organs are lodged in segments ix—xv.

Male organs.—The two pairs of testes and the large fimbriated funnels of the vasa deferentia lie in segments x and xi.

The *testes* are not enclosed in the testicle sacs but are freely projecting from the septa. The testes are small and sometimes missing in large specimens due to degeneration, the worm being protandrous.

There are four pairs of *seminal vesicles* in segments ix-xii those of the segments ix and x are rather small.

Female organs.—A pair of pear-shaped *ovaries* and funnels lie in the xiii segment. A pair of large and very vascular egg sacs in the xiv segment are attached to the septum $\frac{3}{4}$.

Spermathecae.—Two pairs in segments x and xi, their openings to the exterior would hence be in the intersegmental furrows $\frac{9}{10}$ and $\frac{1}{11}$. They are small globular structures, with wall only one cell thick, they lie close to the intestine, have no diverticulum, but a very small duct is seen leading to the exterior. (Fig. 1, Plate II.)

Helodrilus (Binastus) parvus (Eisen).

Habitat.—Very widely distributed throughout, large numbers of it were found along with other worms.

External Characters.—

Length.—45-54 mm., diameter 1-2 $\frac{1}{4}$ mm.

Segments 85-116, generally the number is somewhere about 90.

Colour.—Reddish, clitellum whitish and well marked.

Prostomium epilobous ($\frac{2}{3}$ — $\frac{1}{2}$).

Setae closely paired, four pairs in each segment.

$ab = \frac{1}{4}$ $aa = \frac{1}{3}$ $bc = 1\frac{1}{4}$ cd $dd = \frac{1}{2}$ u nearly.

The first segment is without setae, all others, the clitellum included, have the four pairs of setae each.

Each seta has the posterior end very much curved while the anterior end is distinctly pointed. The nodule is not well marked. The *measurements* of a seta are: *Length* 22 mm., *thickness* = .016 mm.

First dorsal pore in the intersegmental furrow $\frac{5}{6}$. The dorsal pores are distinctly seen on the clitellum also.

Clitellum (Fig. 8, Plate I).—Saddle-shaped occupying segments xxiv—xxx (=7 segm.). In some specimens segment xxxi also was encroached on dorsally.

Male pores are deep transverse clefts in broad longitudinal glandular cushions on segment xv, the cushions in some cases become raised up and appear as papillae. The male pores are in line with the seta *b*.

Female pores mostly invisible, in rather large specimens seen as minute openings on segment xiv, slightly internal to the line of the male openings.

No spermathecal pores as there are no spermathecae.

Genital markings.—Small glandular papillae internal to the ventro-lateral borders of the saddle-shaped clitellum on segments xxv, xxvi, xxix, xxx.

Internal anatomy.—The worms being too small for dissection, the internal anatomy was determined by examining the worms while in *Cedarwood oil* when it is nearly transparent and the rest of the anatomy was made out from vertical longitudinal, horizontal longitudinal, and transverse sections. The sections were either stained with Delafield's hæmatoxylin or with Heidenhain's iron-hæmatoxylin followed by Eosin.

First definite septum is $\frac{3}{4}$. Septa $\frac{6}{7}$ and $\frac{7}{8}$ are thickened.

Alimentary canal.—The *mouth* is overhung by the *prostomium*, and leads into the *buccal cavity* which extends through the first three segments. The buccal cavity is followed by the *pharynx* which has a rather thick muscular wall and the upper surface of it is covered over by a large mass of glandular tissue, the septa extend into this tissue and cut it up according to the segments in which it lies. The pharynx finishes in the sixth or in some cases in the seventh segment whence the œsophagus begins. The *œsophagus* is a straight tube extending up to the fourteenth segment. Only two pairs of *calcareous glands* are to be seen lying in segments xi and xii, the one in segment xi being really a pouch in the side wall of the œsophagus, but the opening of the gland in the xii segment into the œsophagus could not be seen, it merely appeared as a thickening in xii segment showing in sections the characteristic lamellated appearance of the calcareous glands, nor was the opening of this into the anterior one to be made out. The *crop* which follows is a thin walled dilatation of the alimentary canal lying in segments xiv and xv. The *Gizzard* lies in segments xvi and xvii. Its wall consists of the following layers:—

1. Outermost is a single layer of *longitudinal muscular fibres*.
2. Many layers of *circular muscular fibres* come next.
3. A layer of *columnar epithelial cells* is next seen in some places behind the bases of the epithelial cells small rounded cells are also seen filling up the gaps. This layer secretes the *chitinous* lining of the gizzard.

Behind the seventeenth segment the intestine extends as a wide thin walled sacculated tube up to the anus; the intestine in some cases was seen to push the septum $\frac{1}{2}$ forwards on the sides of the gizzard. The intestine is constricted intersegmentally owing to the septa while sacculated in the segments. In the first four or five segments the intestine in the intersegmental regions sends out villus-like projections, which may branch; this appears to be a contrivance for increasing the absorptive surface of the intestine. The *typhlosole* becomes well marked after segment xix and in transverse sections appears as a deep ridge projecting into the cavity of the intestine.

There are five pairs of hearts in segments vii—xi, the ones in segment v being rather small ones.

Nephridia.—are of the *meganephric* type, they are arranged in pairs on each side of the intestine except for the first five segments and the last few in which they are absent.

The *reproductive organs* are lodged in segments xi—xv.

Male organs.—The two pairs of *testes* lie in segments xi and xii free and not enclosed in the testicle sacs. The *seminal funnels* also lie in segment xi and xii. There are only two pairs of *seminal vesicles* depending from the septa $\frac{10}{11}$ and $\frac{11}{12}$ and lying in the segments xi and xii.

Female organs.—A pair of *ovaries* and the *oviducal funnels* lie in the xiii segments, the oviduct pierces the septum $\frac{3}{4}$ and opens on each side on the xiv segment.

Spermathecae absent.

Cocoon formation was observed in one specimen, when found, the cocoon was seen as a raised projection of the clitellum already formed all round the clitellum as a cylinder-like covering, after about two minutes

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the animal began to move in the tube with the anal side forwards and it appeared as if the worm was sliding out of the cocoon. On the cocoon coming to the region of the genital organs, the worm became still for a time and then again the wriggling movement began, and the animal became free of the cocoon in about ten minutes from the time it began the operation. The measurements of the cocoon are as following:—*Length* $2\frac{1}{4}$ mm., *thickness* $1\frac{1}{2}$ mm. (Fig. II, Plate II.) It was of rather a pale white colour, spindle shaped, more or less with a furrow on the original ventral surface and the two ends appeared rather shrivelled up owing to contraction. The cocoon was broken with needles and four *ova* found in it contained in an albuminous matter. No *spermatozoa* however could be distinguished.

Remarks.—The worms required for sectioning were kept in dishes containing wet blotting paper which they quite eagerly devoured at first, the earth gradually passing out of the intestine. They were kept for twenty-eight days in this dish, all except two out of a dozen were found alive and it was seen that their colour became distinctly pinkish from the original red. At this time the worms appeared rather sickly and were very sluggish in their movements; on the blotting paper and dish being changed they became rather active, but only for a very short time when they were killed and preserved.

Pheretima (Kinb. and Mehlsn.)

The various worms of this genus can be distinguished as follows:—

1. No genital papillæ surrounding the male pores or anterior to them on segment xvii (Fig. 1, Plate I) *Pheretima heterochæta*.
2. A pair of papillæ on segments xvii and xix slightly internal to the male pore on each side (Fig. 2, Plate I) *Pheretima posthuma*.
3. Male pore surrounded by two or three genital papillæ on a raised glandular patch of skin, also five to seven papillæ between male pores and a few on segments xvii and xix also (Fig. 3, Plate I) *Pheretima hawayana* subspecies *typica*.
4. Male pore as in the *typical form* but there are no papillæ between the male pores (Fig. 4, Plate I) *Pheretima hawayana* subspecies *barbadensis*.

Pheretima hawayana—subspecies *typica* (Rosa).

Was found in very large numbers throughout. The specimens obtained during the months of December and January were very much smaller in dimensions than those found later in March and April which were very much larger and more robust.

External characters—

Length.—100-120mm., diameter 3-4mm., segments about 90.

Colour.—Yellowish brown.

Prostomium epilobus $\frac{1}{2}$. Segments i—v consist of single annuli vi of two annuli, all the rest except a few at the end of three annuli each; of those at the end first few have two annuli each, while the rest do not show any secondary annulation.

Setæ.—Usually there is a *dorsal* and a *ventral* break.

$$aa = 1\frac{1}{4} ab \quad zz = 1\frac{3}{4} yz$$

$$ab \angle bc \angle cd \dots yz \angle xy \dots ab \angle yz$$

In some cases the ventral break was not to be seen and in others in the posterior part of the body the setæ were disposed in a more or less

unbroken ring. The setæ are somewhat enlarged on segments vii and viii. Clitellum all over devoid of setæ but in some specimens there were setæ on segment xvi ventrally. Numbers of setæ $\frac{20}{v}$ $\frac{44}{vii}$ $\frac{49}{xi}$ $\frac{55}{xix}$ $\frac{58}{xxvi}$.

First dorsal pore in the intersegmental furrow $\frac{10}{11}$ the dorsal pores are easily seen on the clitellum as well.

Clitellum as a ring from about $\frac{3}{4}$ xiv or xiv—xvi (= $2\frac{3}{4}$ or 3 segments).

Male pores on small papillæ on segment xviii about $\frac{1}{3}$ u apart, 18 setæ intervene.

Female pore in a transversely extended depression midventrally on the anterior part of segment xiv.

Spermathecal pores usually two, in some cases three pairs of openings in the intersegmental furrows $\frac{2}{6}$ — $\frac{4}{7}$ or $\frac{5}{8}$ — $\frac{7}{8}$. In an abnormal specimen there were two spermathecal pores in the furrow $\frac{5}{6}$ on the right side corresponding to two spermathecæ in segment vi on the right side and one on the left side.

Genital markings.—Usually 3 papillæ, surrounding the male pore on segment xviii, are situated on an oval glandular patch of skin, the papillæ merge into one another. Internal to the male pores at a slightly posterior level behind the setal ring two to seven papillæ more are to be seen. Five to seven papillæ are seen on each of the segments xvii and xix also. Two or in one case four papillæ were seen on the segment vii and a single one sometimes on the viii segment as well. The papillæ were rather conical projections with a dark centre.

Internal anatomy.—First definite septum $\frac{3}{4}$. Septa $\frac{5}{6}$ and $\frac{4}{5}$ moderately thickened, $\frac{8}{9}$, $\frac{9}{10}$ absent, $\frac{10}{11}$ — $\frac{1}{13}$ also somewhat thickened. In some cases a rudimentary septum $\frac{9}{10}$ resents.

Alimentary tract consists of the following parts:—The *Buccal cavity* in the first two segments is followed by the *Pharynx* i—iv with large pharyngeal glands in segments iii and iv situated dorsally as well as laterally, no internal openings of these glands into the pharynx could be discerned. *Oesophagus* occupying segments v—vii with lateral pouches in vi but no calcareous glands; these lateral pouches were very large in some cases. *Gizzard* in segments viii and ix as a thickened globular sac with a conical posterior end. Intestine rather thin up to septum $\frac{1}{4}$ then becomes wider and passes to the end unchanged. It is covered all round by a thick layer of yellow *chloragogen* cells. The *typhlosole* is seen as a very small ridge dorsally projecting into the cavity of the intestine. *Intestinal diverticula* hollow, conical, beginning from segment xxvi and continued forward to segment xxi. There are from five to seven secondary diverticula of a roundish appearance on the primary diverticulum of each side.

There are four pairs of hearts in x—xiii, there are also a pair of palmate *blood glands* lying on each side of the dorsal blood vessel in each segment after the xxiii segment.

The *nephridia* are of the *micro-nephric* type, diffused on the body wall as well as on the septa. Two large, masses of these nephridia, very richly supplied by blood vessels, were also seen on each side of the oesophagus in segment vii.

The *reproductive organs* are lodged in segments x—xxii.

Male organs.—The two pairs of *testes* lie in the median *testical sacs* in the segments x and xi. The lateral *seminal vesicles* lie in the segments xi and xii depending posteriorly from septa $\frac{1}{11}$ and $\frac{1}{12}$. These are irregularly lobulated. The *vas deferens* in connection with the seminal funnel lying in segment curves over the one from the anterior segment, and this *vas deferens* goes along the outer side of the one from the anterior sac. Both the *vasa defe-*

rentia go side by side separately and are covered by the large masses of ramifying nephridial tubules, they are contives separately in the thickened and curved prostatic duct and do not open into the gland. (Fig. III, Plate II.) This is a difference from what has been stated by Lt.-Col. J. Stephenson, D.Sc., I.M.S., in his paper (3). The vasa deferentia it appears unite with the prostatic duct at its ending point only.

The *prostates* are large occupying segments xvii-xviii divided up into a corresponding number of lobes by the septa; there is a very deep notch on the inner side in segment xix and continued upwards in segment xviii as well. The thick yellow duct begins in this notch in segment xix and after making an S shaped loop opens at the male pore in segment xviii. Moreover it was noticed that there are five additional *primary prostatic ducts* from the lobes of the prostate beginning in the substance of the gland and coming to open into the thick yellow duct. No account of these was given hitherto in all the literature consulted.

Accessory prostates in segments xvii, xviii and xix corresponding in position to the papillæ on the outer surface are to be seen. A glandular mass in segment vii was also to be seen in the position of the papillæ externally.

Female organs.—The *ovaries* are large masses connected with the septum $\frac{1\frac{2}{3}}$ and laying in segment xiii. Oviduct funnels lie in xiii, the *oviducts* of the two sides as far as could be followed did not unite but appeared to open separately. A large *receptaculum ovarum* formed as a bulging in septum $\frac{1\frac{3}{4}}$ could also be seen internally to the funnel of the oviduct.

Spermatheca 2 or 3 pairs mostly two.

The ampulla is ovoid in shape with a small protuberance at the head, it narrows gently into the duct which is well marked and slightly longer than the ampulla. The diverticulum is a thin narrow tube slightly dilated in its distal portion; it reaches nearly to the half of the ampulla. (Fig. IV, Plate II.) The diverticulum arises quite close to the base.

Pheretima hawayana—subspecies *barbadensis* (Beddard).

Found all over Lahore in fairly large numbers.

External characters—

Length.—90-120 mm., diameter 4-4½ mm., segments 85-92.

Colour.—Dirty yellow to brown.

Prostonium epilobous, ($\frac{2}{3}$.) Segments i-iv consist of single annuli v-vi of two annuli each, all the rest of three annuli each.

Setæ in unbroken rings, clitellum usually without setæ but one sexually mature specimen from the Bhati gate gardens had 3 distinct rings of setæ on it. Numbers of setæ $\frac{50}{vii}$ $\frac{58}{xi}$ $\frac{60}{xix}$ and 60 usually in the hinder segments.

First dorsal pore in the intersegmental furrow $\frac{9}{10}$, the pores are distinctly visible on the clitellum as well.

Clitellum as a ring xiv-xvi (=3 seg.); very much darker in colour and of a much lesser diameter than the rest of the body. (Fig. 3, Plate I.)

Male pores on raised ovoid papillæ on segment xviii $\frac{2}{3}u$ apart, 21 setæ intervening.

Female pore in a deep transversely elongated depression on the anterior part of segment xiv.

Spermathecal apertures usually two, seldom three pairs in the intersegmental furrows $\frac{5}{6}$ $\frac{6}{7}$ or $\frac{5}{6}$ - $\frac{7}{8}$.

Genital markings.—Three papillæ surrounding the male pore on each side, in some cases one or two papillæ on segments xvii and xix are also seen. One or two papillæ on segments vii and viii are also seen a little in front of the setal rings.

Internal anatomy.—First definite septum is $\frac{2}{3}$. Septa $\frac{5}{6}$ and $\frac{6}{7}$ moderately thickened, $\frac{7}{8}$, $\frac{8}{9}$ wanting and the septa $\frac{9}{10}$ — $\frac{7\frac{1}{2}}{12}$ are also thickened.

Intestinal diverticula.—Simple originating in xxvi segment and coming forwards up to the segment xxii.

Testicle sacs in x and xi separate from the lateral *seminal vesicles* in segments xi and xii. The seminal vesicles are compact and not much lobulated.

Prostate gland occupies segments xvii—xxi. *Prostatic duct* thick and straight opening in segment xviii to the exterior, into it open the five primary prostatic ducts as in *Pheretima hawayana* typical form. No accessory prostates could be made out. The *vas deferens* in connection with the seminal funnel in the xi segment curls over the one from the septa x, and passes back external to it. The two vasa deferentia open separately close to each other into the thick prostatic duct.

Spermathecae two seldom, three pairs in segments vi and vii or in vi—viii. The ampulla is of an inverted pyriform shape with a notch on one side. The duct is well marked and slightly smaller in length than the ampulla. The diverticulum is smaller in than the ampulla and arises at a much higher level from the duct than in *Pheretima hawayana*. (Fig. V, Plate II.)

Remarks.—There has been a good deal of difference of opinion as to whether *Pheretima barbadensis* should be considered as a subspecies of the typical form of *Pheretima hawayana* or as a distinct species. Stephenson discussed the whole fully in his papers "On a collection of Oligochaeta mainly from Ceylon" in the "*Spolia zeylanica*" (4) and in "Contributions to the fauna of Yunan" (3) and arrived at the conclusion that *Pheretima barbadensis* should be classed as a subspecies of the typical form *Pheretima hawayana*. But from the very large number of forms collected in Lahore and examined I have to conclude that these two should be classed as two distinct subspecies. The chief points in which the *barbadensis* form differs from the typical *hawayana* are:—

Unbroken rings of setae, clitellum occupying the whole of three segments without setae usually and being well marked owing to being lesser in diameter than the rest of the body. (Fig. 3, Plate I.) Absence of *genital papillae* in the interval between the male pores and on segments xvii and xix and the corresponding absence of the accessory glands internally; the genital papillae surrounding the male pore being scattered and not fused (as in *Pheretima hawayana*) to form the oval area, the prostatic duct being straight and not curved in an shaped manner; the difference in the shape of the *spermathecal* ampullae and the point of origin of the diverticulum and in the *intestinal coeca* being simple.

While working for some time at the Indian Museum, Calcutta, I examined the Yunan and Ceylon specimens mentioned by Stephenson in his papers (4, 5) and I find that the abovementioned opinions are in no way effected by their examination.

Pheretima posthuma (L. Vaillant).

Very widely distributed though not in so large numbers as the other species of the genus *Pheretima*.

External characters—

Length.—115-130 mm., diameter 5 mm., Segments about 140.

Colour.—Rich, brown.

Prostomium tanylobous.—Segments i—vi consist of single annuli vii and viii of two annuli and the rest of three, the secondary annulation is lost towards the posterior end.

Setae form an unbroken ring, clitellum was sometimes without setae, in other cases three indistinct rows of setae were to be seen on it. Numbers of setae $\frac{144}{vi} \frac{108}{x} \frac{95}{xx} \frac{92}{xxx}$.

First dorsal pore in intersegmental furrow $\frac{12}{13}$.

Clitellum as a ring occupying segments xiv—xvi (= 3 seg.).



Fig. I.
× 25.



Fig. II.
× 10.

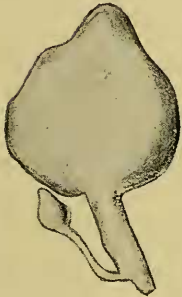


Fig. VII.
× 20.



Fig. V.
× 10.

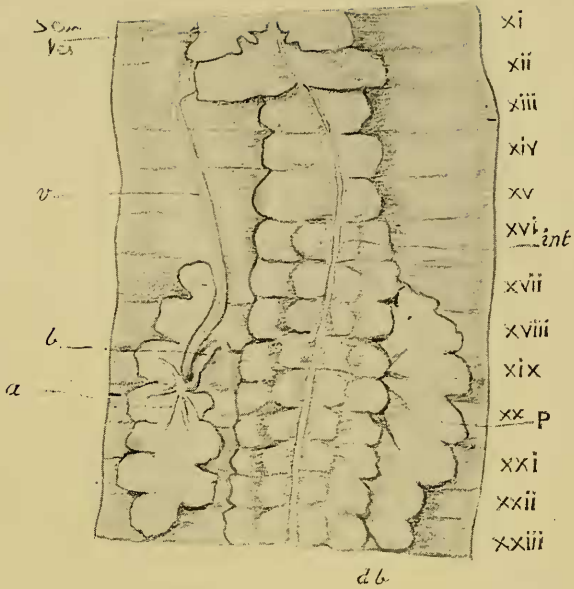


Fig. III.
× 5.

a Primary prostatic ducts. *b* Prostatic duct. *db* Dorsal blood vessel, *int* intestine. *p* prostates. *sem ves* vesicula seminalis, *v* vasa deferentia. Lateral blood vessels not shown



Fig. VI.
× 20.



Fig. IV.
× 25.

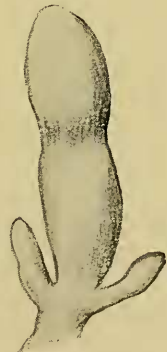


Fig. VIII.
× 15.

Male pores on large elevated papillæ on segment xviii about $\frac{1}{4}u$ apart from each other 19 or 20 setæ intervene.

Female pore as a small opening in the midventral line on segment xiv on the setal ring.

Spermathecal pores, four pairs in the intersegmental furrows $\frac{5}{6}—\frac{8}{6}$ situated ventro-laterally $\frac{1}{3}u$ apart 47 setæ intervene.

Genital papillæ.—In line with or slightly internal to the line of the male pores there are a pair of papillæ on the segments xvii and xix respectively on each side; in addition to these in some cases there were papillæ on segments xx, xxi, xxii in line with the one on segment xix, the limits varied on both sides even in the same specimen. In one there were papillæ on xix, xx, xxii segments on the right side, but only on xix on the left side.

Internal anatomy.—First definite septum is $\frac{4}{5}$, septa $\frac{5}{6}—\frac{7}{6}$ very much thickened. Septum $\frac{8}{6}$ is slightly so, while the septum $\frac{8}{6}$ or $\frac{10}{6}$ is missing, septum $\frac{11}{6}$ is also thickened.

The gizzard occupies segment vii or segments viii and ix when septum $\frac{8}{6}$ is missing. The intestine lies in a straight line between the gizzard and the anus, it becomes wider after segment xiv. The typhlosole is not so well marked, but is only a slight ridge projecting into the intestine. There are a pair of *intestinal diverticula* in xxvi, these are elongated, conical without secondary projections, they extend forwards up to segments xxi.

Two pairs of hearts in xii and xiii. There are a pair of "*blood glands*" in each segment lying on either side of the dorsal blood vessel after segment xxvi.

The *Nephridial System* is *micronephric*, the nephridia are a system of diffused tubules with many funnel-like openings in each segment; a large mass of nephridial tubes is to be seen on either side of the oesophagus in segment vi.

Two median *testicle sacs* in segments x and xi, and three pairs of lateral *seminal vesicles* in x, xi and xii segments; the seminal vesicles communicate with each other and are of a large size.

The *Prostates* are large occupying segments xvi—xxi. They are irregularly lobulated. The thick prostatic duct begins in line with the septum $\frac{18}{6}$ and loops forwards to open at the male pore in xviii segment.

Accessory glands lie close to the prostates in segments xvii and xix.

Ovary and oviduct funnels lie in segment xiii.

Spermathecæ (Fig. VI, Plate II) are four pairs in segments vi—ix. The ampulla is ovoid or somewhat globular in shape, the duct is slightly longer than the ampulla; the diverticulum is rather elongated and narrow and reaches up to the ampulla.

Cocoons of Pheretima posthuma.—While digging for this worm a number of cocoons were also found. These were of a faint yellowish colour of the following size:—*Length* $4\frac{1}{2}$ mm., *diameter* $3\frac{1}{4}$ mm. These were barrel shaped pointed at both ends and appeared much shrivelled at both ends. (Fig. 7, Plate I). Some were in very early stages showing eggs only while one contained a single fully developed worm lying in an albuminous mass, with no trace of the other eggs. It is rather curious that of the many eggs laid in a cocoon only a single one should develop, the rest all degenerating to supply food for that single individual. This is well known in other cases.

Pheretima heterochæta (Mehlsn.).

Fairly widely distributed throughout Lahore.

External characters—

Length.—125-135 mm., diameter 4-5 mm. Segments about 110.

Colour.—Yellowish or brownish, clitellum however always brownish.

Prostomium epilobous ($\frac{2}{3}$.) No secondary annulation of the segments.

Setæ raised on a distinct ridge which is very prominent in the post-clitellar region. There is no dorsal break but a ventral break is present in the preclitellar region. Behind the clitellum the line of *Seta a* is not quite straight as it is in front of the clitellum, hence the *Setæ* there appear more or less irregularly arranged.

Preclitellar arrangement $a\ a = 1\frac{3}{4}\ a\ b > b\ c > c\ d \dots\dots\dots$

Setæ a and *b* are larger than others.

First dorsal pore on the intersegmental furrow $\frac{1}{2}$ pores, indicated on the clitellum also.

Clitellum as a ring, smooth with no indication of *setæ* or intersegmental furrows, usually xiv—xvi (= 3 segments) in some cases posterior part of segment xiii also encroached on dorsally.

Male pores on slightly elevated papillæ on segment xviii $\frac{2}{5}\ u$ apart 14 *setæ* intervening.

Female pore on segment xiv on a large papilla in a circular depression.

Spermathecal pores.—Four pairs in the intersegmental furrows $\frac{5}{6}$ — $\frac{8}{9}$ on the ventro-lateral borders.

Genital markings.—Two pairs of median papillæ on segments vii and viii, also a papilla on each of the four segments v—viii just overhanging the spermathecal pores. The arrangement was not so definite in all specimens in some cases there being only one or two on vii and viii segments and no others.

Internal anatomy.—Septum $\frac{4}{5}$ is the first definite one, septa $\frac{6}{6}$ — $\frac{7}{7}$ thickened, $\frac{8}{8}$ — $\frac{9}{9}$ wanting, $\frac{10}{11}$ and $\frac{11}{12}$ also thickened.

Gizzard between $\frac{7}{8}$ — $\frac{10}{11}$ somewhat conical, narrower in front than behind. *Intestinal cæca* are simple and lie in segments xxvi—xxii.

Four pairs of *hearts* in segments x—xiii.

The *reproductive organs* are lodged in segments x—xxi.

Male organs.—Two pairs of *testes* lie in the median *testicle sacs* in segments x and xi; these communicate with each other. Two pairs of *seminal vesicles* in segments xi and xii depending from septa $\frac{10}{11}$ and $\frac{11}{12}$. The seminal vesicles are lobed irregularly.

Prostates.—Usually one of the two is reduced and the other quite absent; in a few specimens both were absent. The prostatic duct is however to be seen as a swollen tube showing an inverted S-shaped curve in segment xviii, when prostates are absent, the prostatic duct is then in continuation of the *vasa deferentia* on each side.

Female organs.—A large *receptacula ovarum* is present as a bulging from septum $\frac{1}{4}$ on each side.

Spermatheca.—Four pairs in segments vi—ix. The ampulla is shield-shaped, in outline and well marked off from the duct which is slightly shorter than the ampulla. The diverticulum is long, swollen into a knob-like dilatation. (Fig. VII, Plate II.)

Lampito mauritii (Kinb.).

Only one partially dissected specimen in spirit from the new Shalimar side and four specimens from Kapurthala. All these specimens were in the collection of my worthy professor and patron Lt.-Col. J. Stephenson, D.Sc., I.M.S., through whose very great kindness I had an occasion of examining this interesting form. I am also indebted to him for allowing me to use his manuscript, notes on the external characters of the Lahore form in order to complete my account of the same.

External characters—

Length.— $8\frac{1}{2}$ inches, diameter 5 mm., segments 166.

Colour.—Dark yellow, darker purplish tinge at the anterior end.

Prostomium probolous in the Lahore form while *Epilobous* in the specimens from Kapurthala.

First five segments consist of single annuli while segments vi and vii of two annuli each, and rest of the preclitellar segments of three each; no distinct secondary annulation behind the clitellum.

Setæ are in a chain which is interrupted ventrally but there is no dorsal break, usually $z=z=yz$ sometimes a little more than yz .

$$aa=2\frac{1}{2}-3ab > bc > cd.$$

Seta a is especially enlarged and the line of setæ aa in all the preclitellar segments is nearly straight.

The numbers of the setæ are as follows:— $\frac{38}{vi}$ $\frac{44}{x}$ $\frac{34}{xxi}$ and 33 in the middle part of the body.

First dorsal pore in the intersegmental furrow $\frac{10}{11}$.

Clitellum extends over xiv—xvii (=4 segments). Setæ are present on the clitellar segments.

The male apertures are situated on large rounded papillæ on segment xviii, these in turn are overhung by large glandular areas which take up the whole length of the segment and encroach a little on segment xix also. The interval between the male pores is nearly $\frac{1}{4}u$, there are no setæ between the male pores (Fig. 6, Plate I).

Female pore could not be distinguished.

No spermathecal apertures are visible and there are no other genital marks of any kind.

Internal anatomy.—Septum $\frac{5}{6}$ very thin and delicate, $\frac{6}{7}$ rather thin and the septa $\frac{7}{8}$ — $\frac{12}{13}$ thick and muscular, $\frac{13}{14}$ and onwards thin but very definite.

The Gizzard is in segment v. Michaëlsen in his "*Oligochaeta*" (1) in the "*Tierreich*" says that it lies in segment vi, while in his "*Indian oligochaeta*" (2) he says it lies in v (vi?). The difference is probably due to the earlier observers having not distinctly seen the thin and delicate septum $\frac{5}{6}$.

There are no calciferous glands nor any intestinal diverticula.

There are five pairs of hearts in segments ix—xiii.

Excretory system.—Both *micro* and *meganephridia* are to be seen in this form. The *micronephridia* are seen as conspicuous masses lying on the sides of the intestine from segments xv onwards, but they occur in the more anterior segments also where they are nearer the midventral line and are hidden by the cone within cone arrangement of the septa themselves.

The *meganephridia* begin about segment xx and appear to be due to the increased development of one of the tubule in the micronephric mass. They are small at first but about the xxx segment where they reach their full size they are as very conspicuous tubes one on each side of the intestine lying between the micronephric mass.

Reproductive organs are lodged in segments ix—xix.

Male organs.—The testes and seminal funnels are free in segments x and xi. The paired seminal vesicles lie in segments ix—xii. They are irregularly cut up into small lobes. There are no median seminal vesicles. The prostates are rather thick of an opaque white color lying in segments xviii and xix, the prostatic duct is thick and shows an S-shaped curve.

The penial setæ are slightly curved at the end, the free end is slightly bifid. Round the distal portion of the shaft there are a number of prominent spines arranged in rather irregular rows on the shaft. (Fig. 15, Plate I).

Female organs.—The ovarian funnels as well as ovaries lie in segment xiii, the oviduct is xiv, hence the female opening externally would be on segment xiv.

The spermathecae are three pairs lying in segments vii—ix, hence they would open externally in the intersegmental furrow $\frac{6}{7}$ — $\frac{8}{9}$. The ampulla is elongated with a constriction in the middle, it gradually narrows towards

the external opening, the duct being not distinctly marked off. From close to the base arise two club-shaped diverticula, one on each side $\frac{1}{3}$ as long as the ampulla (Fig. VIII, Plate II.)

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EXPLANATION OF PLATE I.

- Figure 1.—Genital area of *Pheretima heterochæta*. ♀ Female pore, ♂ Male pore.
- Figure 2.—Genital area of *Pheretima posthuma*. G. Genital papilla. ♀ Female pore, ♂ Male aperture.
- Figure 3.—Genital area of *Pheretima barbadensis*. ♀ Female pore. Cl. Clitellum, ♂ Male aperture. G. Genital papilla.
- Figure 4.—Genital area of *Pheretima hawayana*. Setæ on the segment xvi indicated where they are present ventrally. ♀ Female pore, G. Genital papilla. ♂ Male pore.
- Figure 5.—Clitellum of *Helodrilus caliginosus* forma *trapezoides*. S. setæ. C. Cushion formed by the genital area.
- Figure 6.—Segments xviii—xx of *Lampito mauritii*. ♂ Male pore.
- Figure 7.—Cocoon of *Pheretima posthuma*.
- Figure 8.—Clitellum of *Helodrilus parvus* ventral view. S. Setæ. G. Genital papillæ.
- Figure 9.—Segments xiv—xvi of *Helodrilus caliginosus*. ♀ Female pore, ♂ Male aperture.
- Figure 10.—Segments ix—xi of *Helodrilus caliginosus*. G. Genital areas of a glandular nature surrounding the setæ.
- Figure 11.—Seta a, segment, x, *Helodrilus caliginosus*.
- Figure 12.—Seta a, hinder part of the body, *Helodrilus caliginosus*.
- Figure 13.—Seta a, segment x, *Helodrilus parvus*.
- Figure 14.—Seta of *Pheretima heterochæta*.
- Figure 15.—Distal end of penial seta of *Lampito mauritii* showing ornamentation.

Roman numerals refer to the numbers of segments.

EXPLANATION OF PLATE II.

- Figure I.—*Helodrilus caliginosus* forma *trapezoides* spermatheca.
- Figure II.—*Helodrilus parvus*—Cocoon.
- Figure III.—*Pheretima hawayana* sub. sp. *typica*. Segments xi-xxiii dissected out to display the internal anatomy.
- Figure IV.—*Pheretima hawayana* sub. sp. *typica* spermatheca.
- Figure V.—*Pheretima hawayana* sub. sp. *barbadensis* spermatheca.
- Figure VI.—*Pheretima posthuma*—Spermatheca.
- Figure VII.—*Pheretima heterochæta*—Spermatheca.
- Figure VIII.—*Lampito mauritii*—Spermatheca.